Track reconstuction efficiency in jets

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- Track embedding in jets
  - Tuning the embedded MC track
  - Definition of efficiency
  - Results in terms of:

    Jet E_t

    Track P_t

    Distance from jet core

    Distance from closest track
- Conclusion

Track embedding

- Method:

  Embed hits from simulated charged pion track in jet

  Reconstruct event with new track

  See if track is reconstructed

- The jet:

  Simulation does not reproduce hit occupancy well

  $\Rightarrow$ Trigger Jet20, Jet50 and Jet70 (around 400 000 each)

  $\Rightarrow$ Triggered jet not used to avoid trigger bias

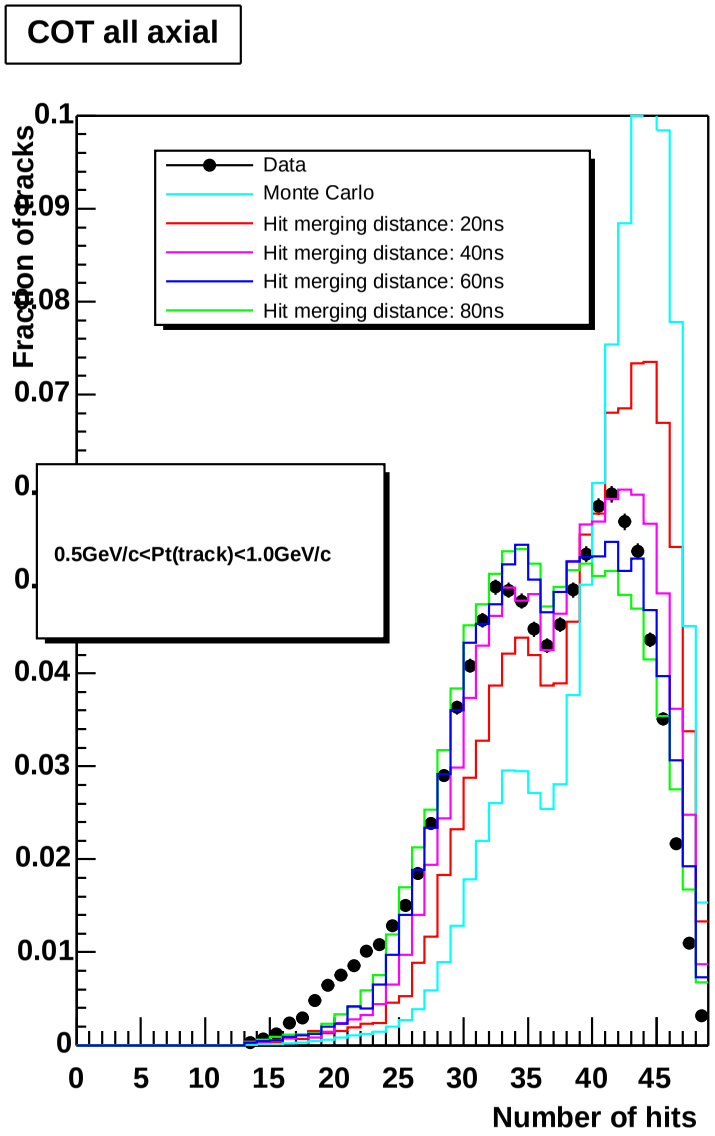
- Comparison with MC:

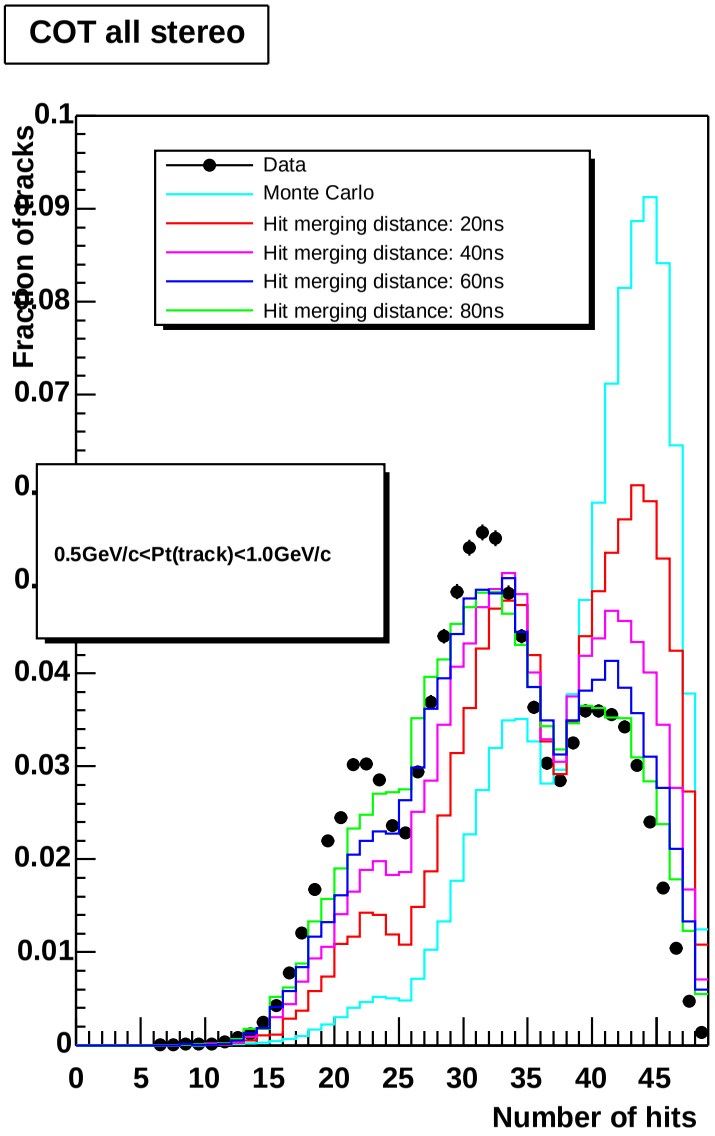
  Use pythia jets dijet40 and dijet60

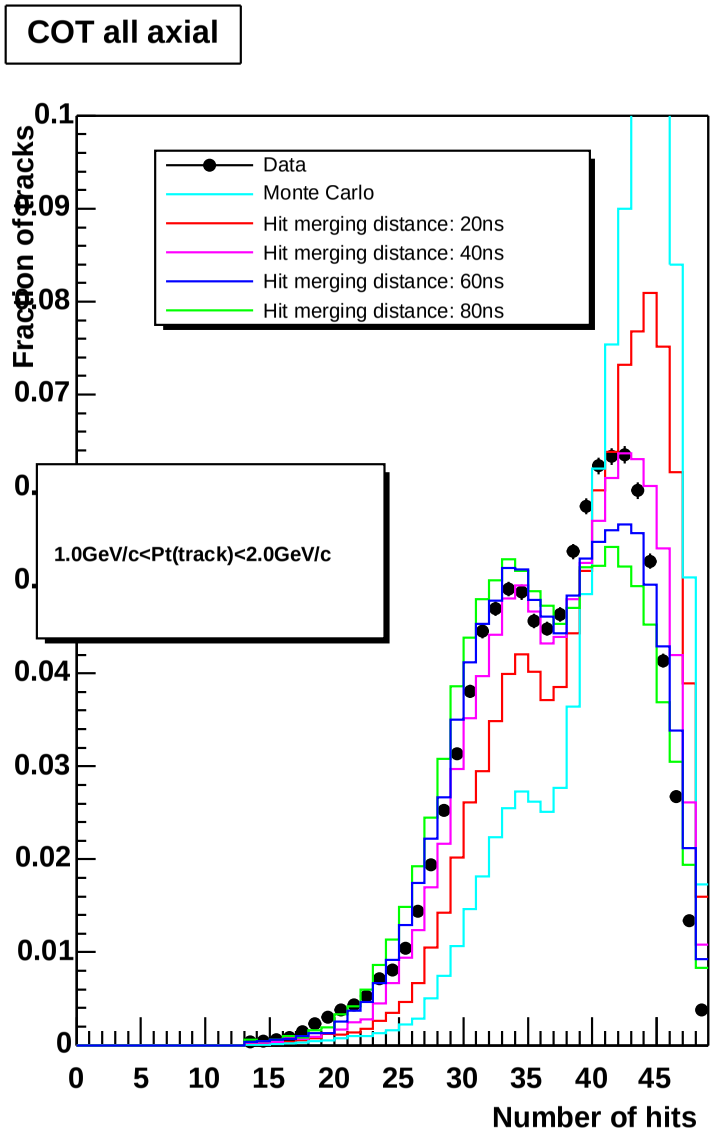
  Look at pion OBSP from primary vertex directed in jet cone

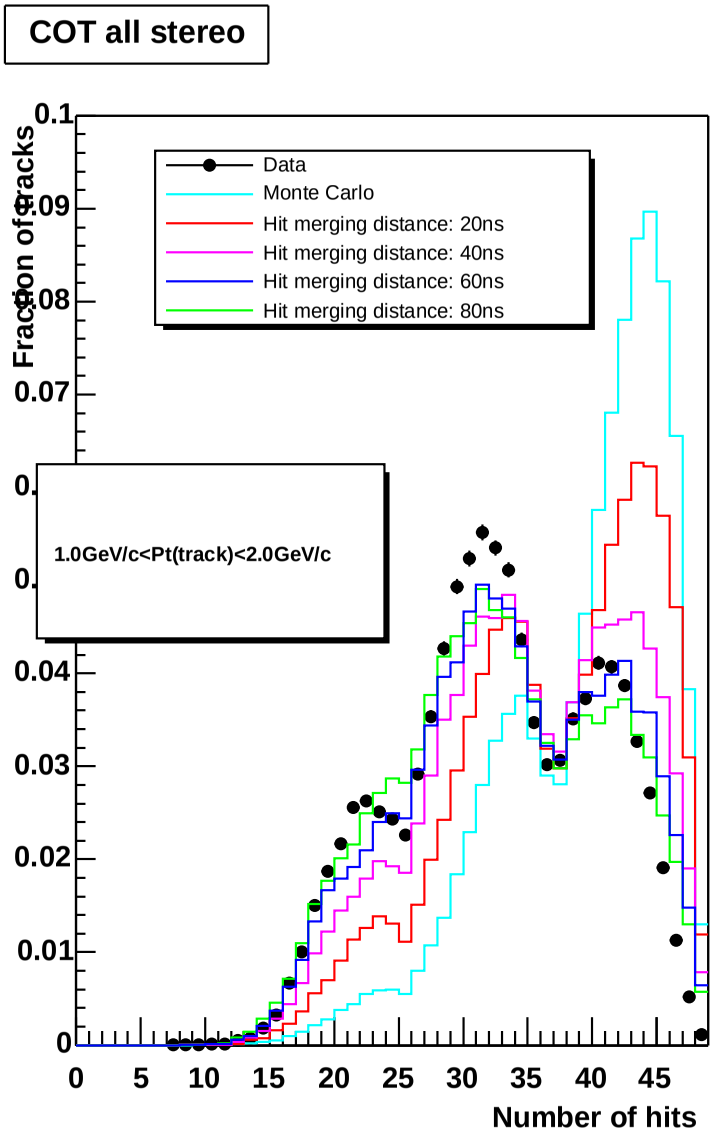
Tuning the embedded MC track

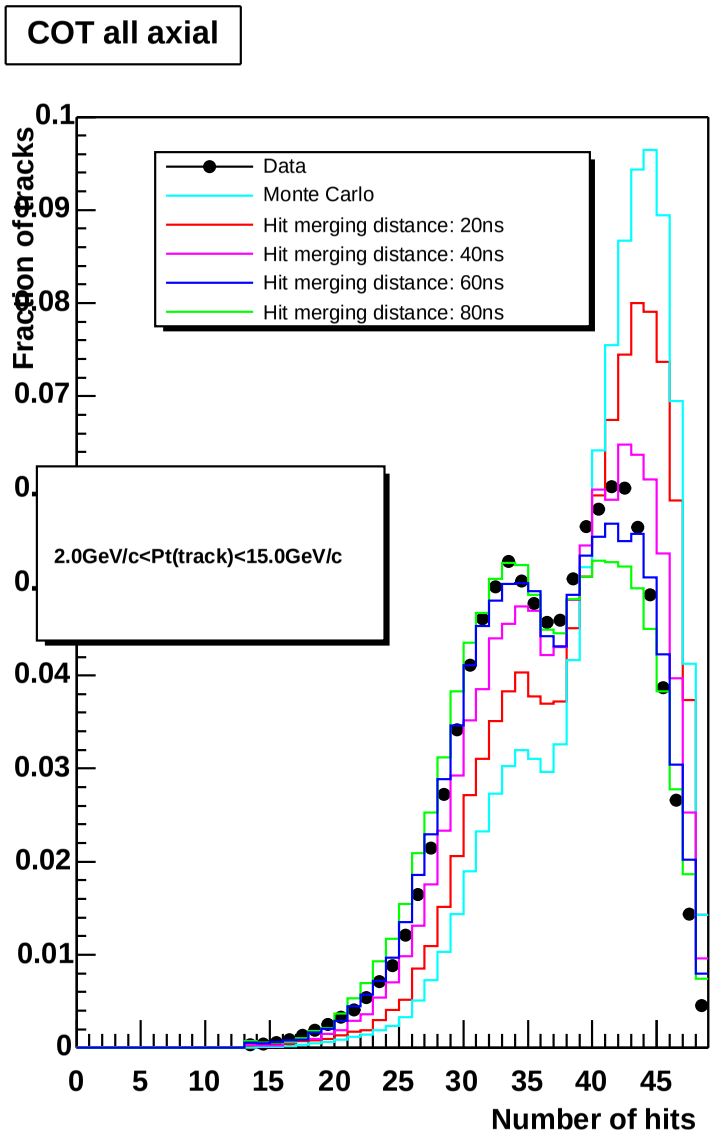
- Embedded tracks must be tuned to emulate data tracks in jets
  - Distribution of number of axial and stereo hits attached to track (hit merge distance 60ns)
  - Distribution of the track hit residual (smearing scale factor 0.8)
  - Distribution of hit width

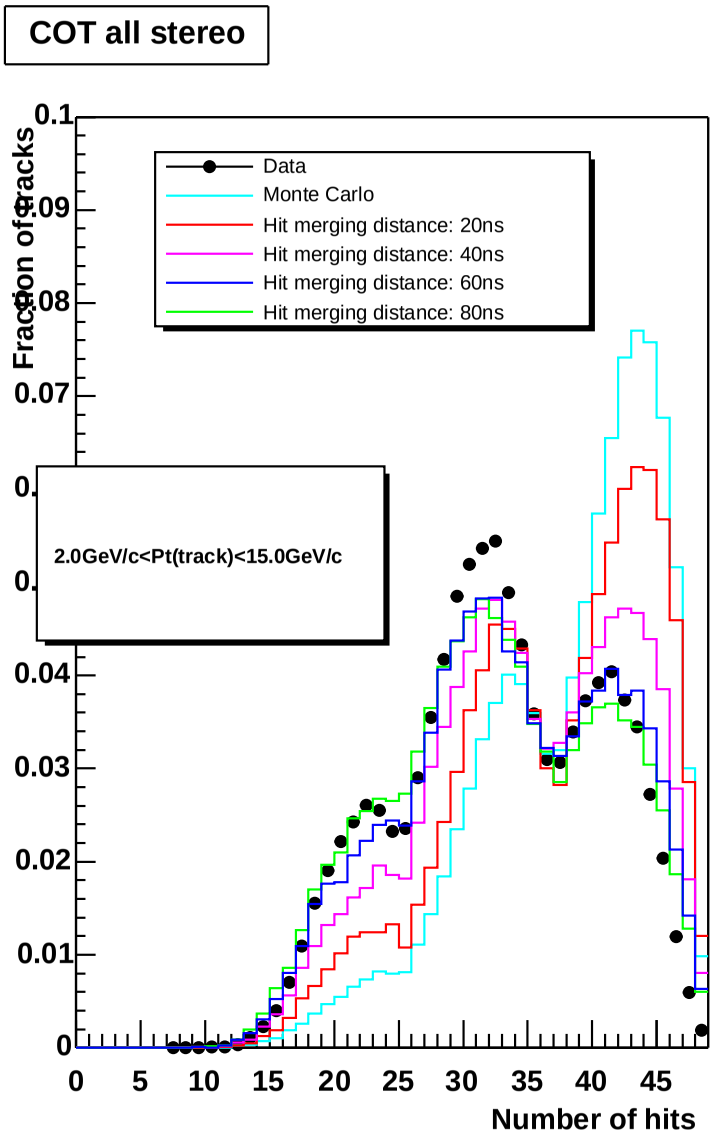

COT all axial
Data
Monte Carlo
Hit merging distance: 20ns
Hit merging distance: 40ns
Hit merging distance: 60ns
Hit merging distance: 80ns
0.5GeV/c<Pt(track)<1.0GeV/c
Fraction of tracks
Number of hits

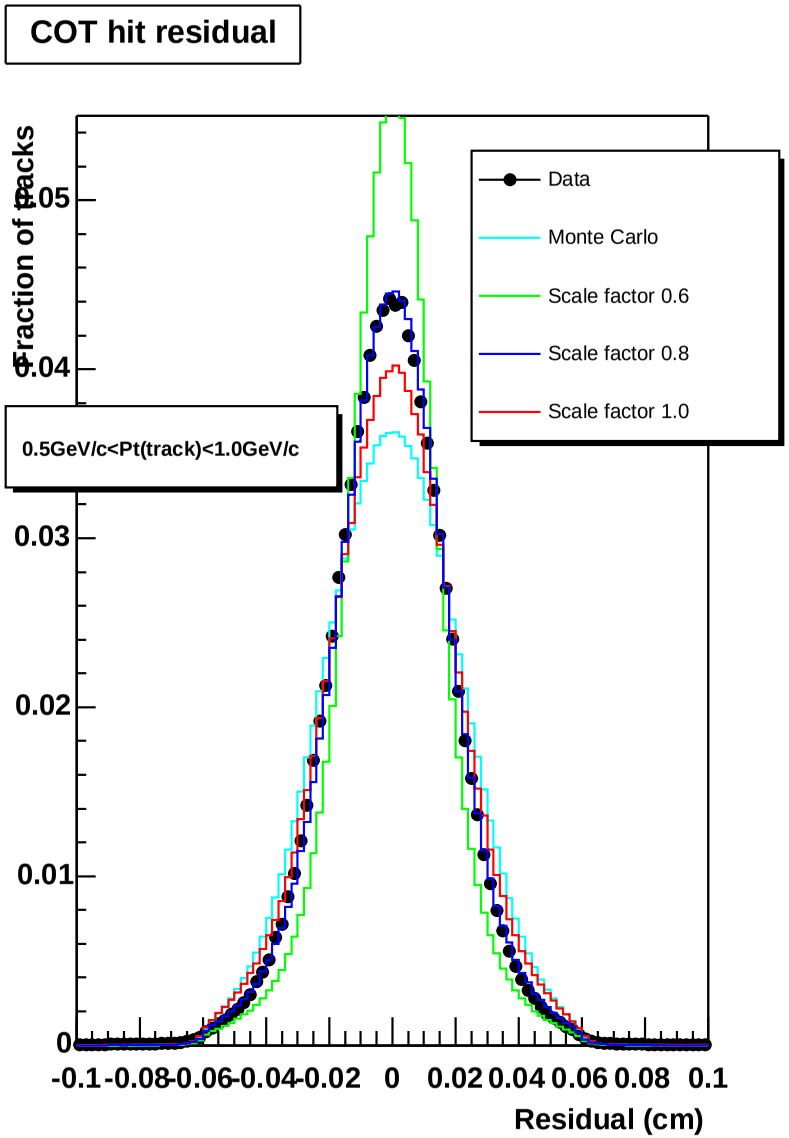

COT all stereo
Data
Monte Carlo
Hit merging distance: 20ns
Hit merging distance: 40ns
Hit merging distance: 60ns
Hit merging distance: 80ns
0.5GeV/c<Pt(track)<1.0GeV/c
Fraction of tracks
Number of hits

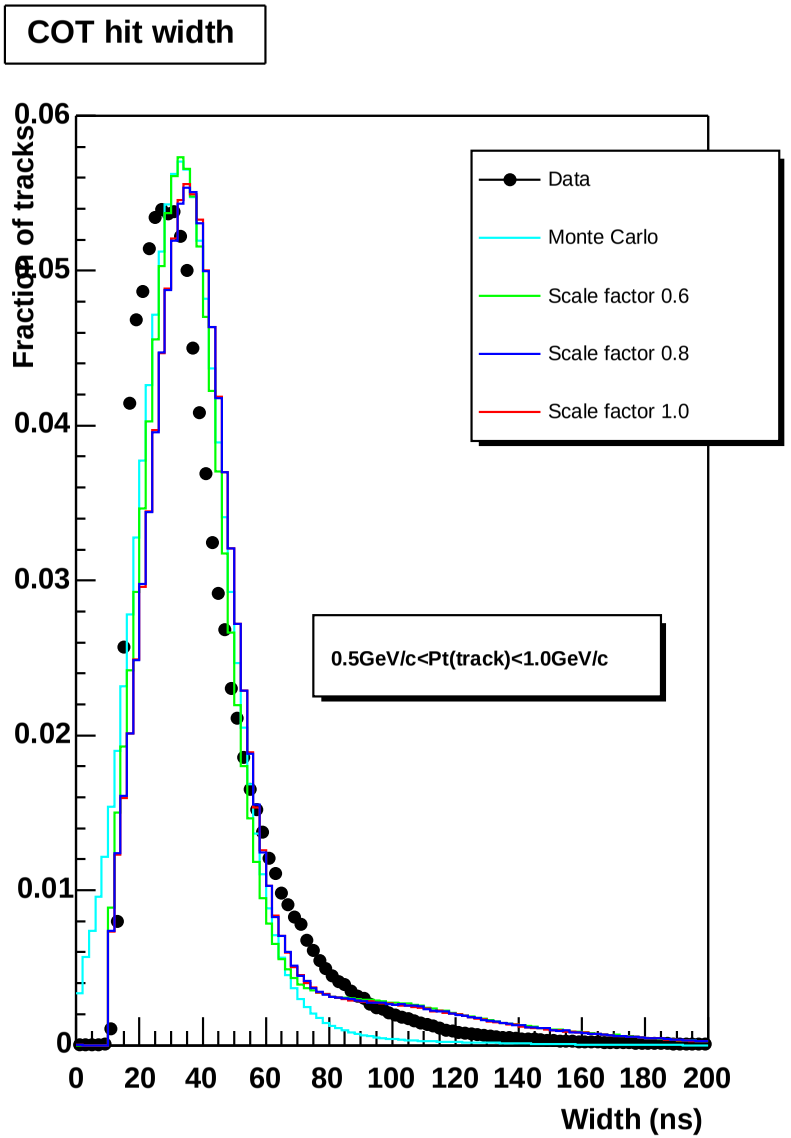

COT all axial
Data
Monte Carlo
Hit merging distance: 20ns
Hit merging distance: 40ns
Hit merging distance: 60ns
Hit merging distance: 80ns
1.0GeV/c<Pt(track)<2.0GeV/c
Fraction of tracks
Number of hits

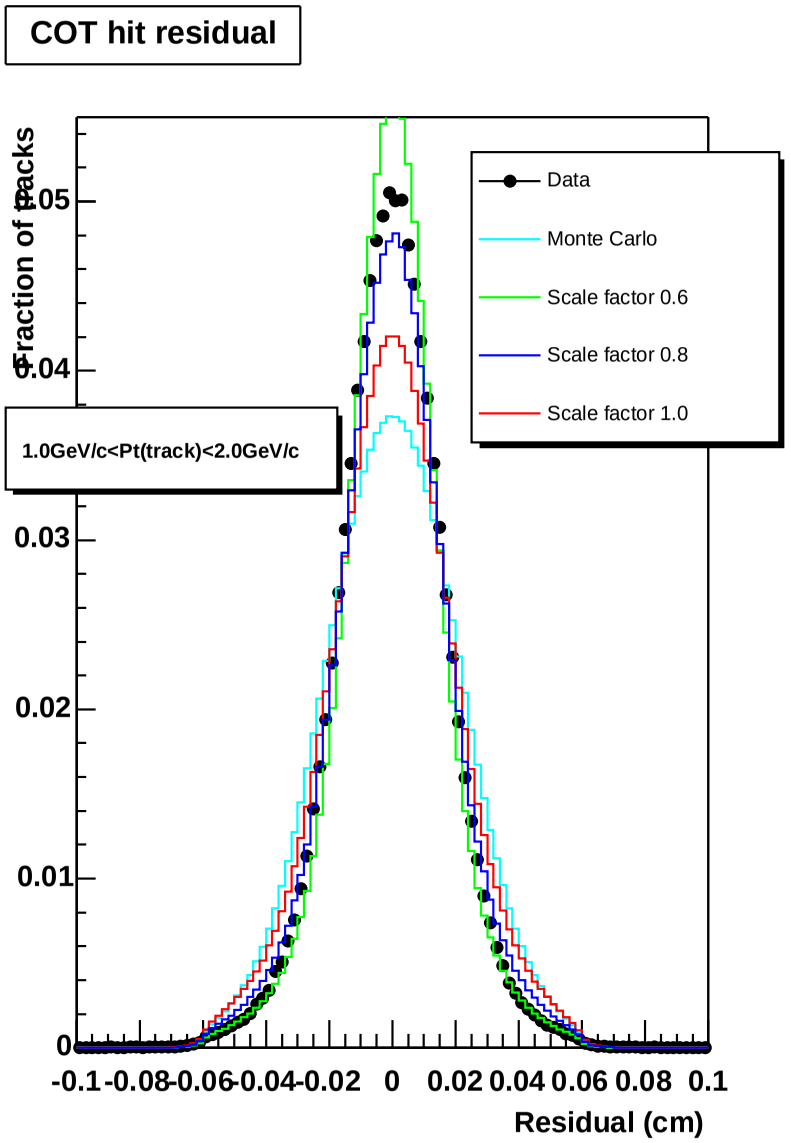

COT all stereo
Data
Monte Carlo
Hit merging distance: 20ns
Hit merging distance: 40ns
Hit merging distance: 60ns
Hit merging distance: 80ns
1.0GeV/c<Pt(track)<2.0GeV/c
Fraction of tracks
Number of hits

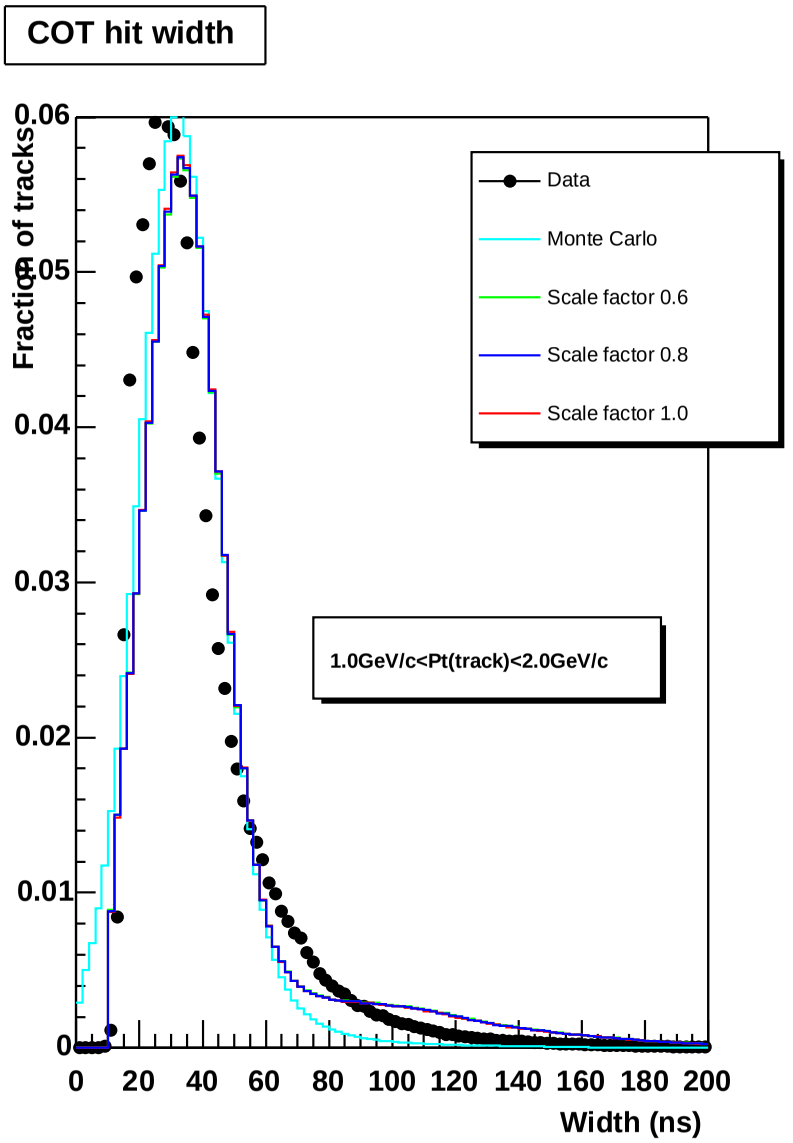

COT all axial
Data
Monte Carlo
Hit merging distance: 20ns
Hit merging distance: 40ns
Hit merging distance: 60ns
Hit merging distance: 80ns
2.0GeV/c<Pt(track)<15.0GeV/c
Fraction of tracks
Number of hits

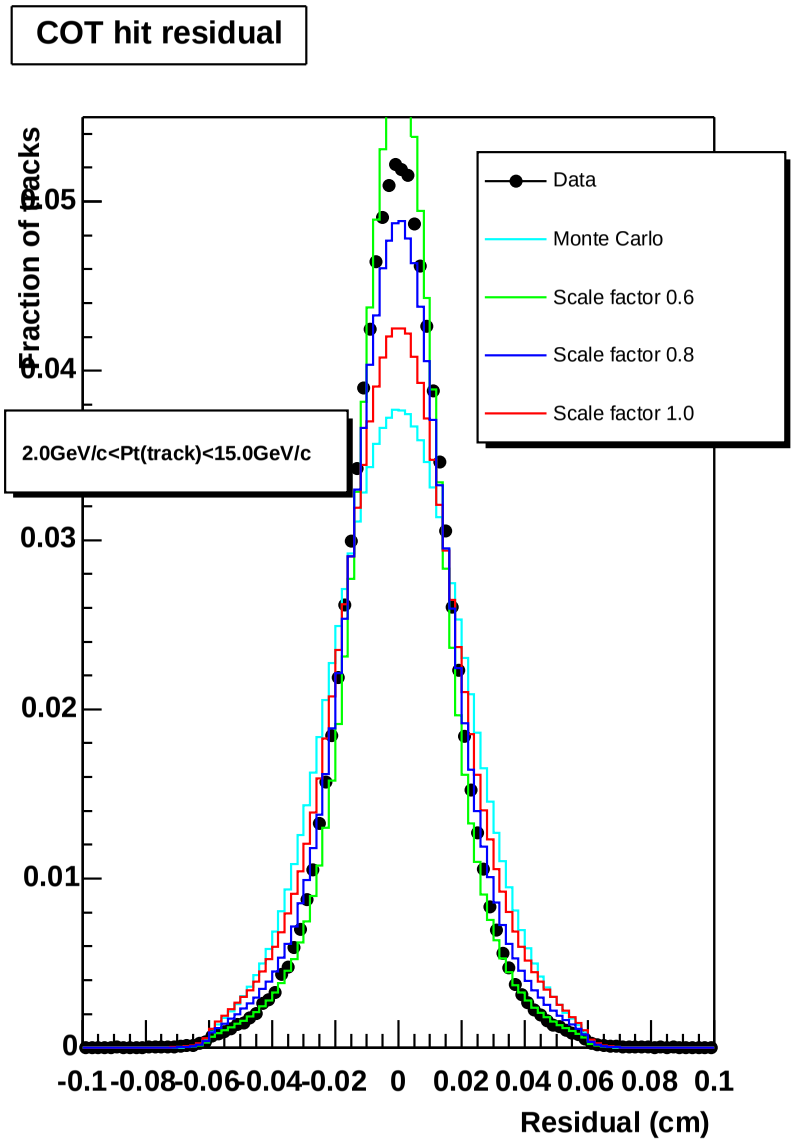

COT all stereo
Data
Monte Carlo
Hit merging distance: 20ns
Hit merging distance: 40ns
Hit merging distance: 60ns
Hit merging distance: 80ns
2.0GeV/c<Pt(track)<15.0GeV/c
Fraction of tracks
Number of hits

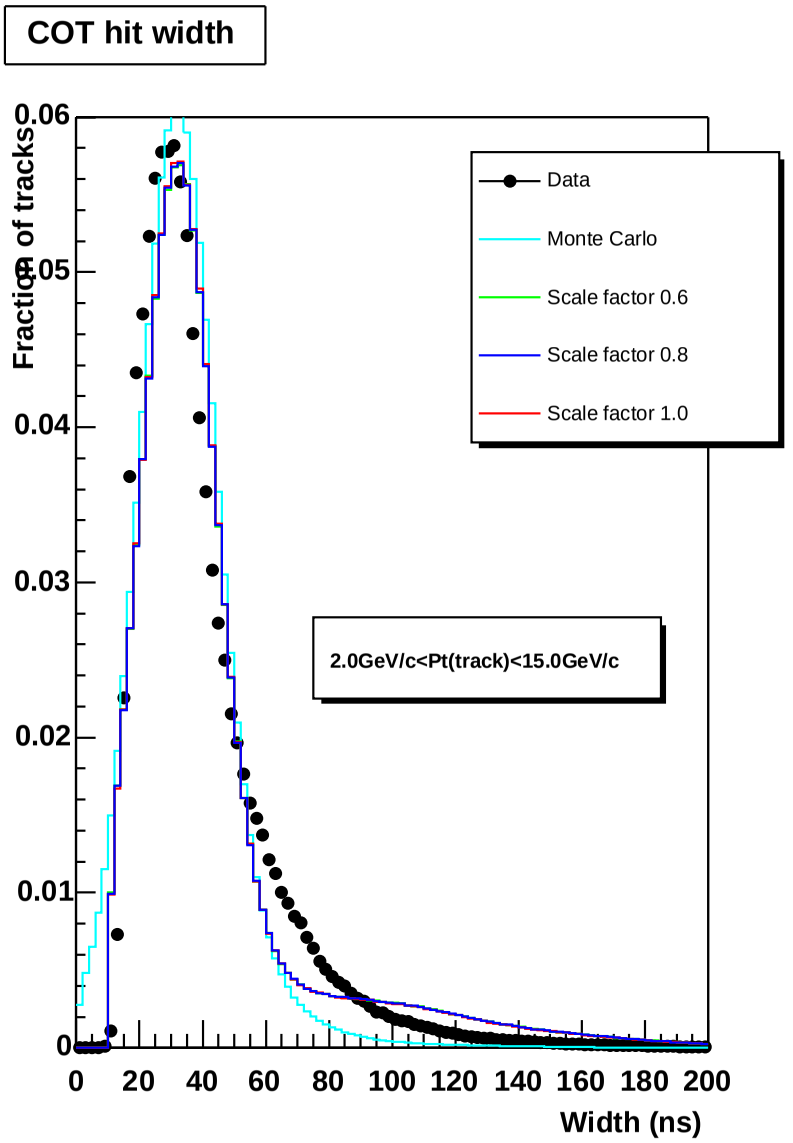

COT hit residual
Fraction of tracks
0.05
0.04
0.03
0.02
0.01
0
0.5GeV/c<Pt(track)<1.0GeV/c
Data
Monte Carlo
Scale factor 0.6
Scale factor 0.8
Scale factor 1.0
-0.1 -0.08 -0.06 -0.04 -0.02 0 0.02 0.04 0.06 0.08 0.1
Residual (cm)


COT hit width
Fraction of tracks
0.06
0.05
0.04
0.03
0.02
0.01
0
0.5GeV/c<Pt(track)<1.0GeV/c
Data
Monte Carlo
Scale factor 0.6
Scale factor 0.8
Scale factor 1.0
0 20 40 60 80 100 120 140 160 180 200
Width (ns)


COT hit residual
Fraction of tracks
0.05
0.04
0.03
0.02
0.01
0
1.0GeV/c<Pt(track)<2.0GeV/c
Data
Monte Carlo
Scale factor 0.6
Scale factor 0.8
Scale factor 1.0
-0.1 -0.08 -0.06 -0.04 -0.02 0 0.02 0.04 0.06 0.08 0.1
Residual (cm)


COT hit width
Fraction of tracks
0.06
0.05
0.04
0.03
0.02
0.01
0
Data
Monte Carlo
Scale factor 0.6
Scale factor 0.8
Scale factor 1.0
1.0GeV/c<Pt(track)<2.0GeV/c
0 20 40 60 80 100 120 140 160 180 200
Width (ns)


COT hit residual
Fraction of tracks
0.05
0.04
0.03
0.02
0.01
0
2.0GeV/c<Pt(track)<15.0GeV/c
Data
Monte Carlo
Scale factor 0.6
Scale factor 0.8
Scale factor 1.0
-0.1 -0.08 -0.06 -0.04 -0.02 0 0.02 0.04 0.06 0.08 0.1
Residual (cm)


COT hit width
Fraction of tracks
0.06
0.05
0.04
0.03
0.02
0.01
0
Data
Monte Carlo
Scale factor 0.6
Scale factor 0.8
Scale factor 1.0
2.0GeV/c<Pt(track)<15.0GeV/c
0 20 40 60 80 100 120 140 160 180 200
Width (ns)

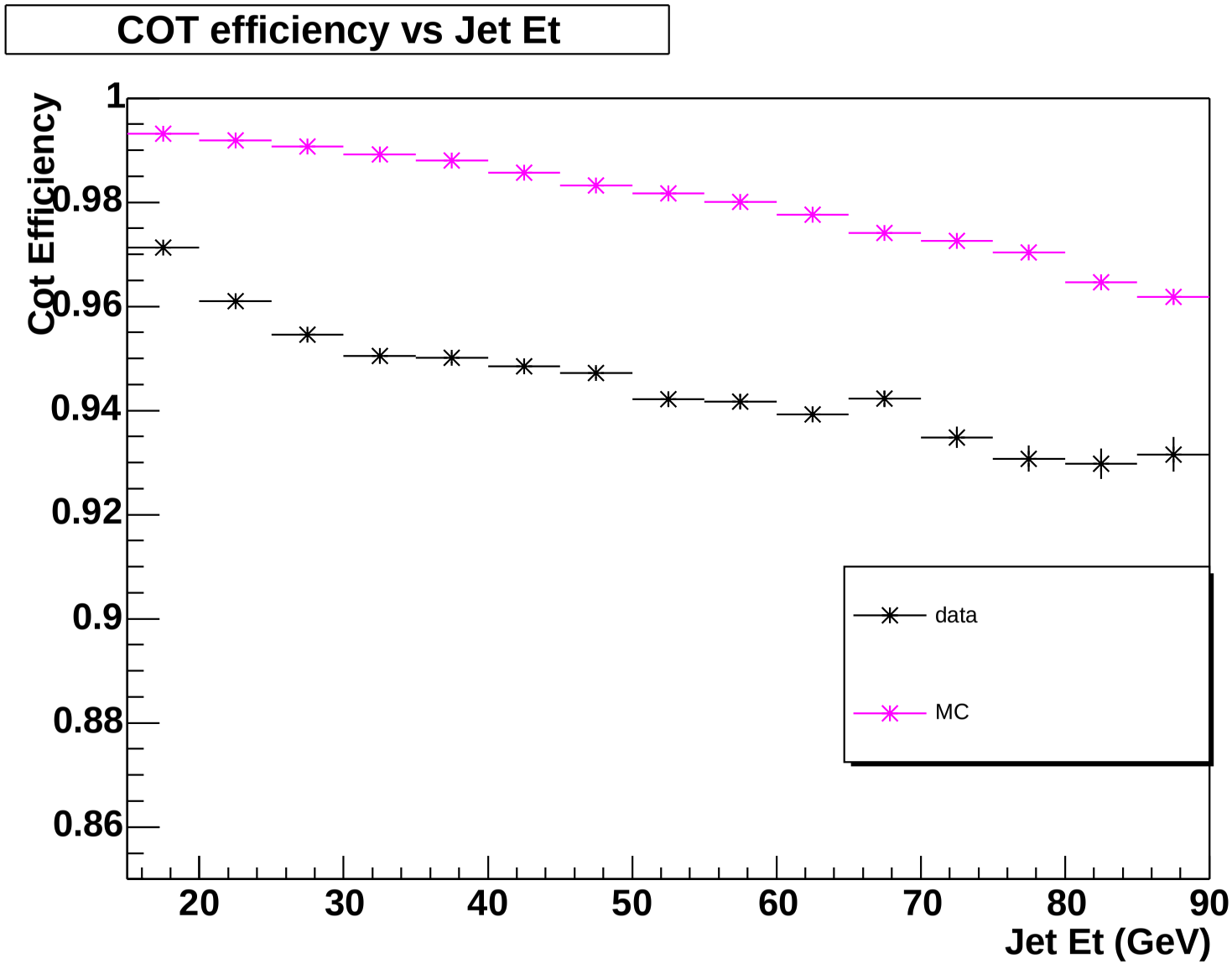
Definition of efficiency

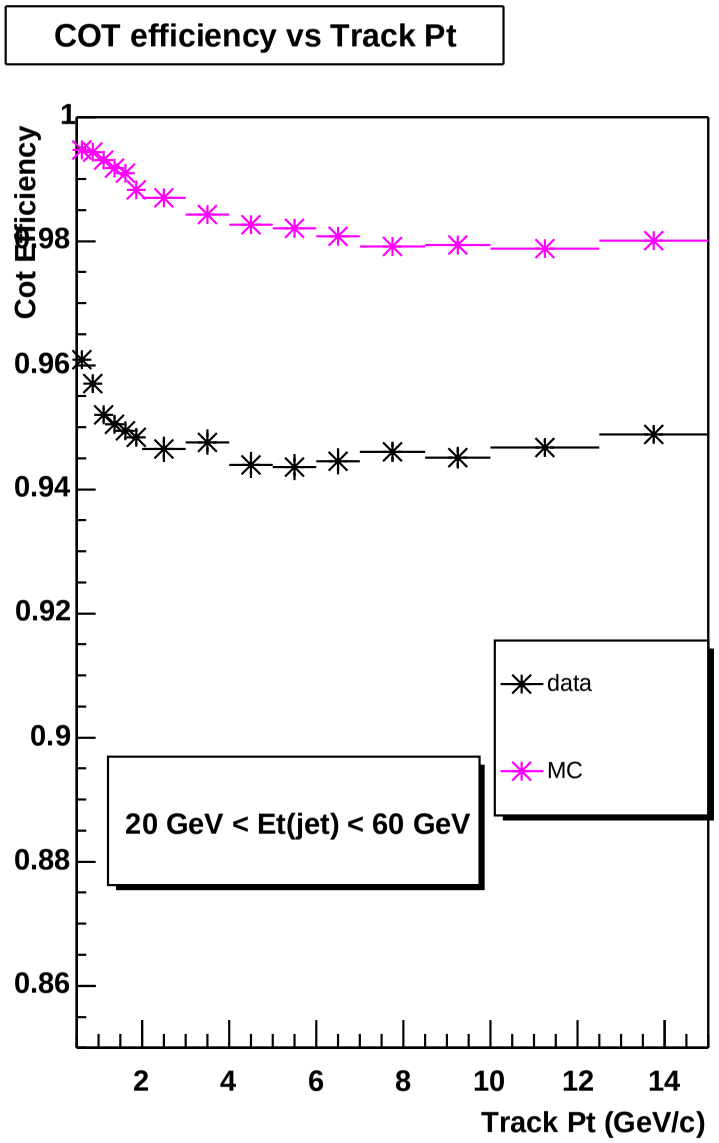
Denominator: the embedded track

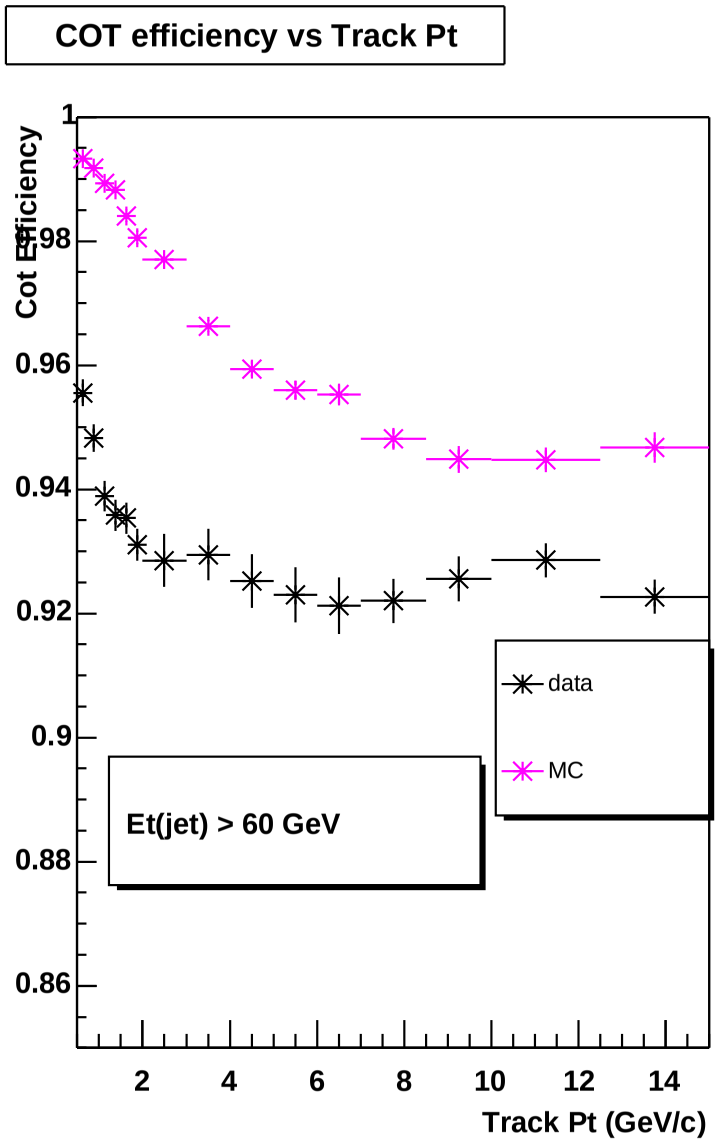
- Charged pions that don't have a decay (or interaction) vertex
- Random P_t from 0.5 to 15 GeV/c
- Flat random angular distance from jet core between 0 to 0.7 rads
- COT fiducial ($|cotz| < 149cm$)

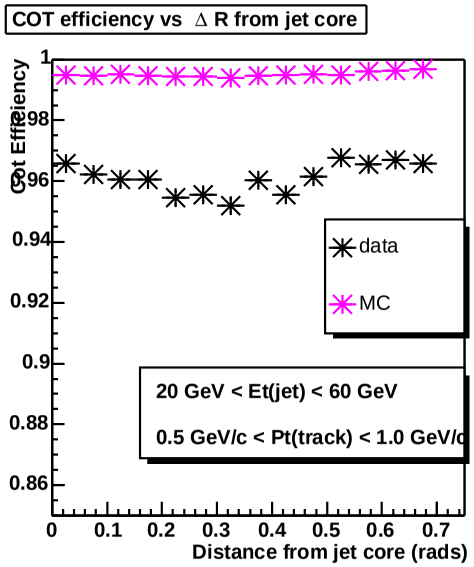
Numerator: any of these two criteria satisfied to compare OBSP helix and reconstructed tracks

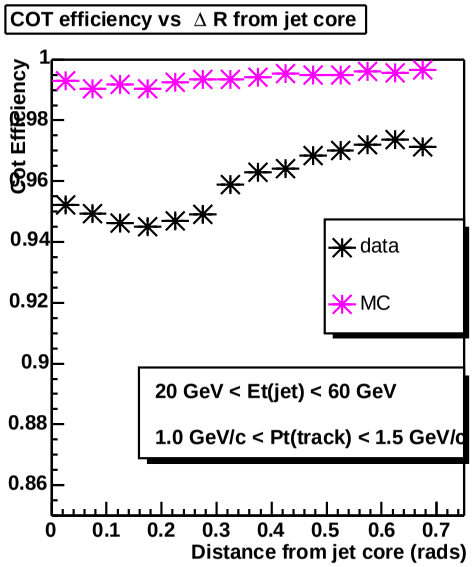
- At least 10 more hit match than any other track
- Or 1 hit match + $\Delta d0 < 0.4$, $\Delta\Phi < 0.013$ and $\Delta curvature < 0.00004$

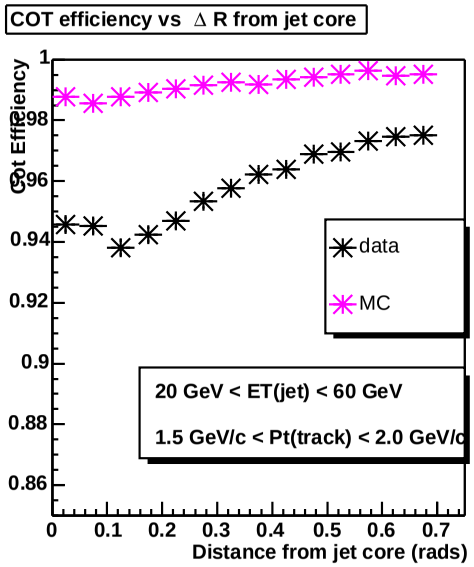

COT efficiency vs Jet Et
Cot Efficiency
1
0.98
0.96
0.94
0.92
0.9
0.88
0.86
20
30
40
50
60
70
80
90
Jet Et (GeV)
data
MC

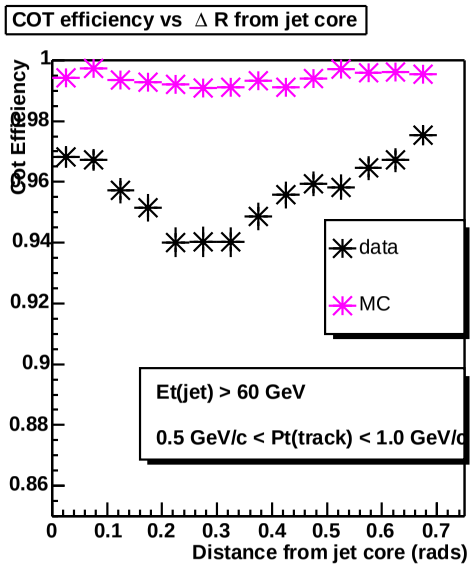

COT efficiency vs Track Pt
Cot Efficiency
1
0.98
0.96
0.94
0.92
0.9
0.88
0.86
2
4
6
8
10
12
14
Track Pt (GeV/c)
data
MC
20 GeV < Et(jet) < 60 GeV

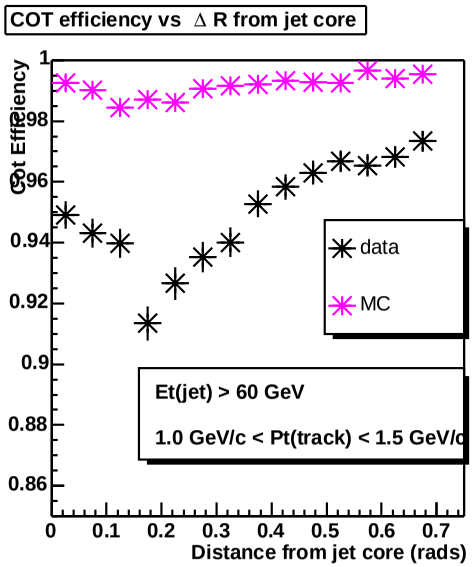

COT efficiency vs Track Pt
Cot Efficiency
1
0.98
0.96
0.94
0.92
0.9
0.88
0.86
2
4
6
8
10
12
14
Track Pt (GeV/c)
data
MC
Et(jet) > 60 GeV

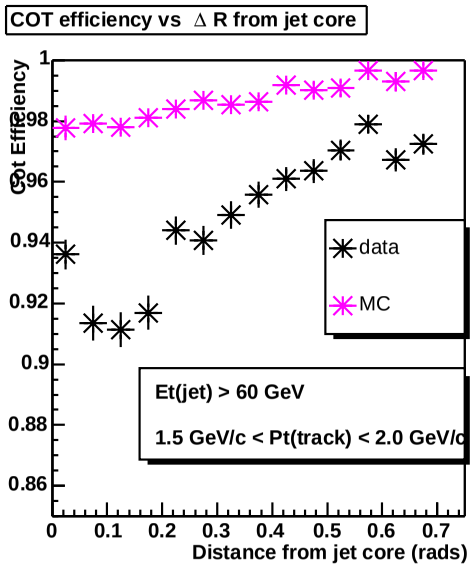

COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
20 GeV < Et(jet) < 60 GeV
0.5 GeV/c < Pt(track) < 1.0 GeV/c


COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
20 GeV < Et(jet) < 60 GeV
1.0 GeV/c < Pt(track) < 1.5 GeV/c

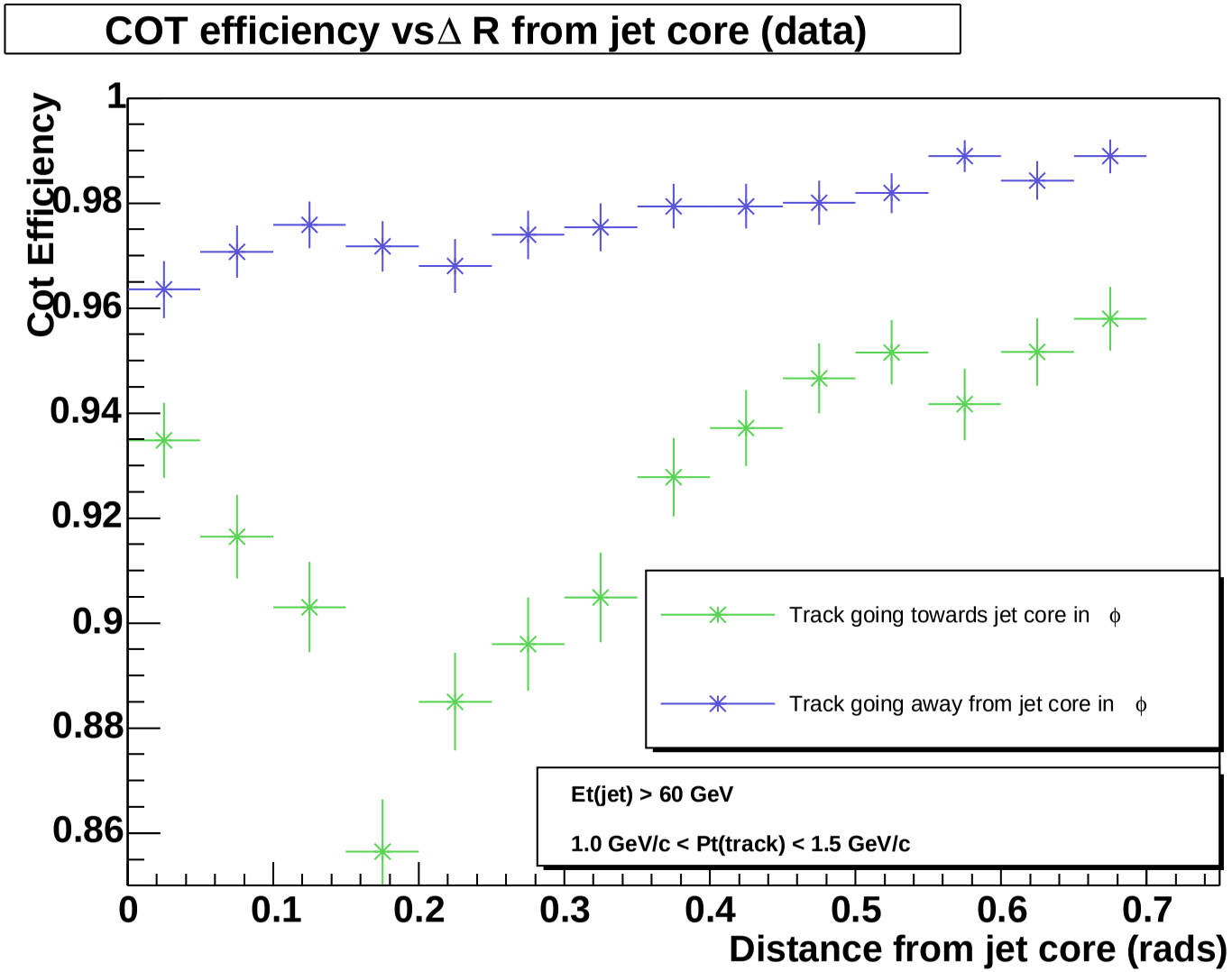

COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
20 GeV < ET(jet) < 60 GeV
1.5 GeV/c < Pt(track) < 2.0 GeV/c

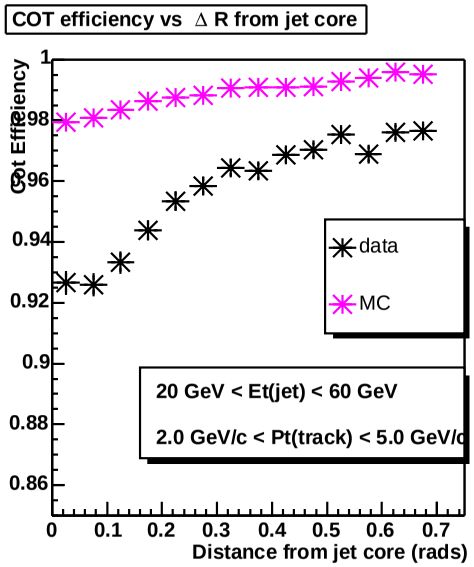

COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
Et(jet) > 60 GeV
0.5 GeV/c < Pt(track) < 1.0 GeV/c

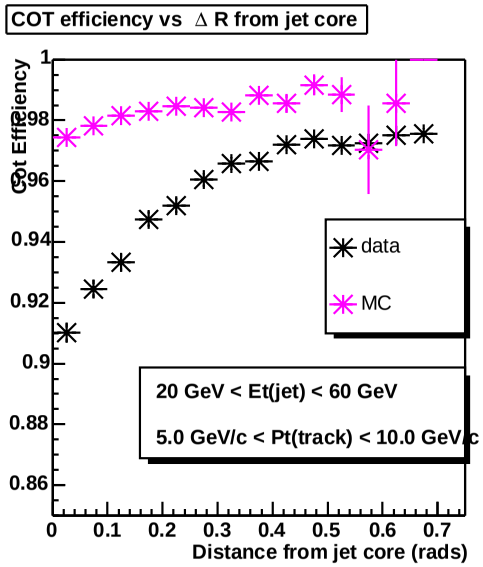

COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
Et(jet) > 60 GeV
1.0 GeV/c < Pt(track) < 1.5 GeV/c

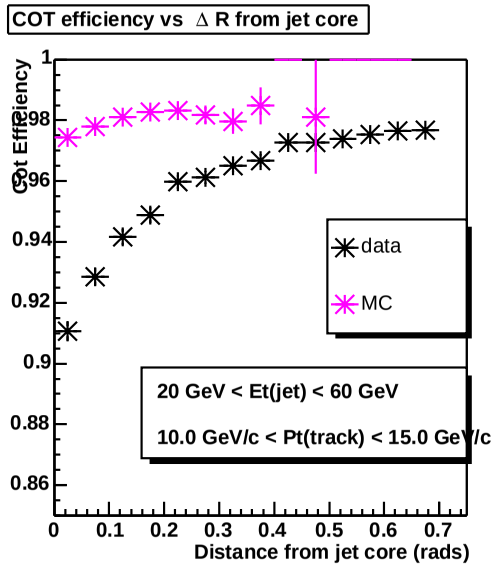

COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
Et(jet) > 60 GeV
1.5 GeV/c < Pt(track) < 2.0 GeV/c

Why does the efficiency dip down?




COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
20 GeV < Et(jet) < 60 GeV
2.0 GeV/c < Pt(track) < 5.0 GeV/c


COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
20 GeV < Et(jet) < 60 GeV
5.0 GeV/c < Pt(track) < 10.0 GeV/c


COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
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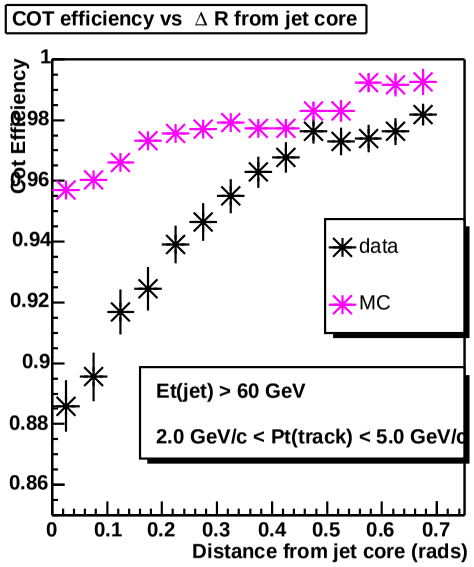
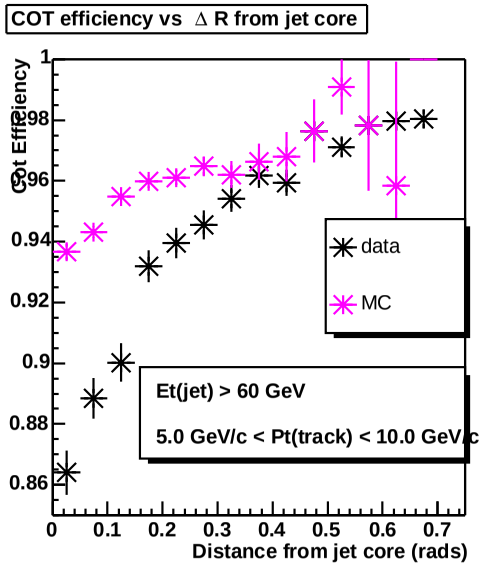
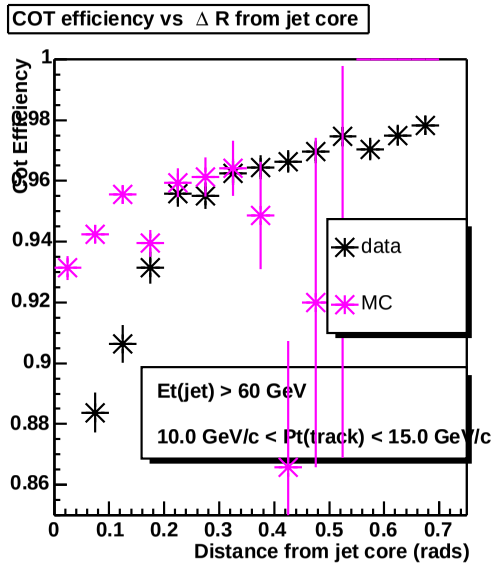
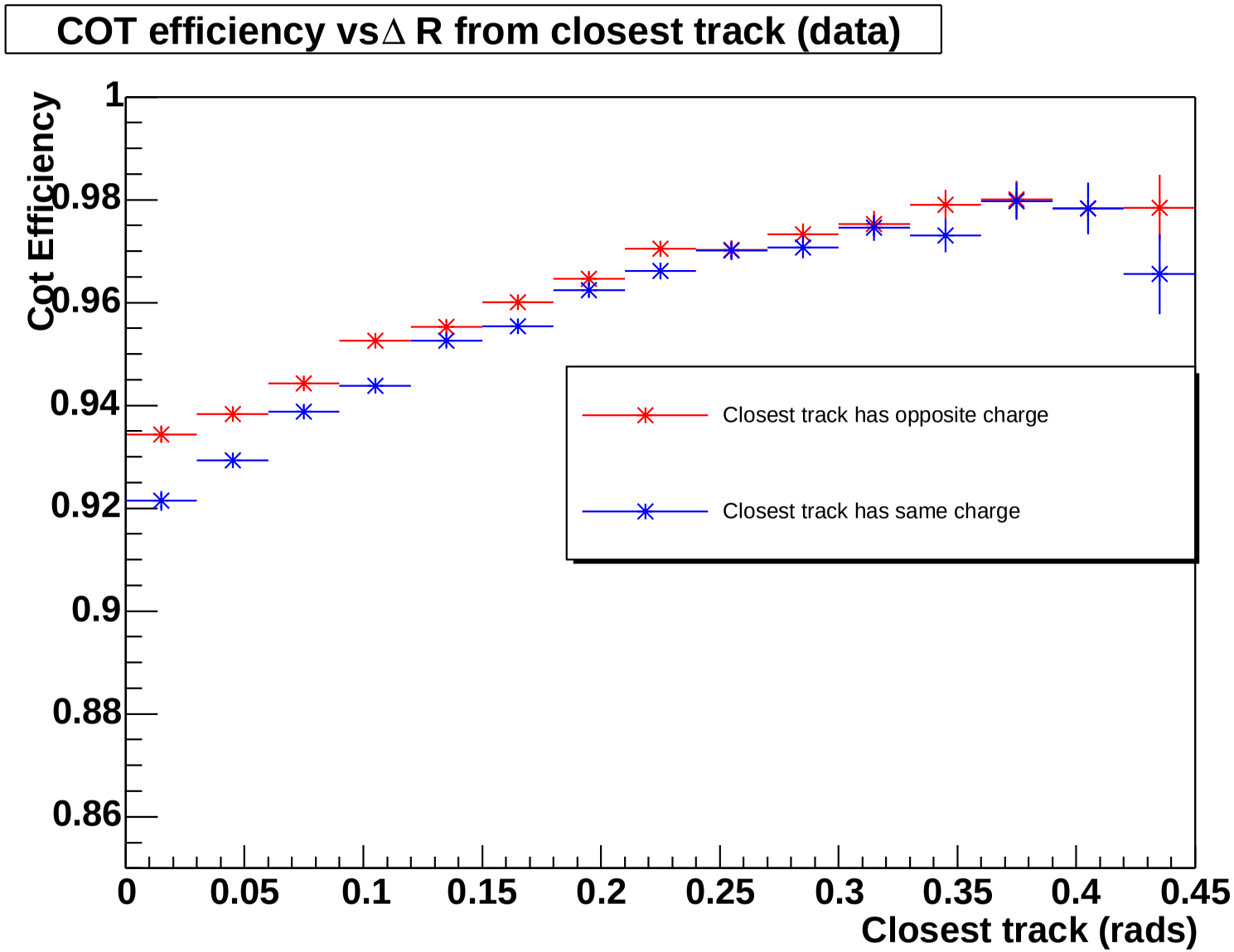
10.0 GeV/c < Pt(track) < 15.0 GeV/c


COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
Et(jet) > 60 GeV
2.0 GeV/c < Pt(track) < 5.0 GeV/c

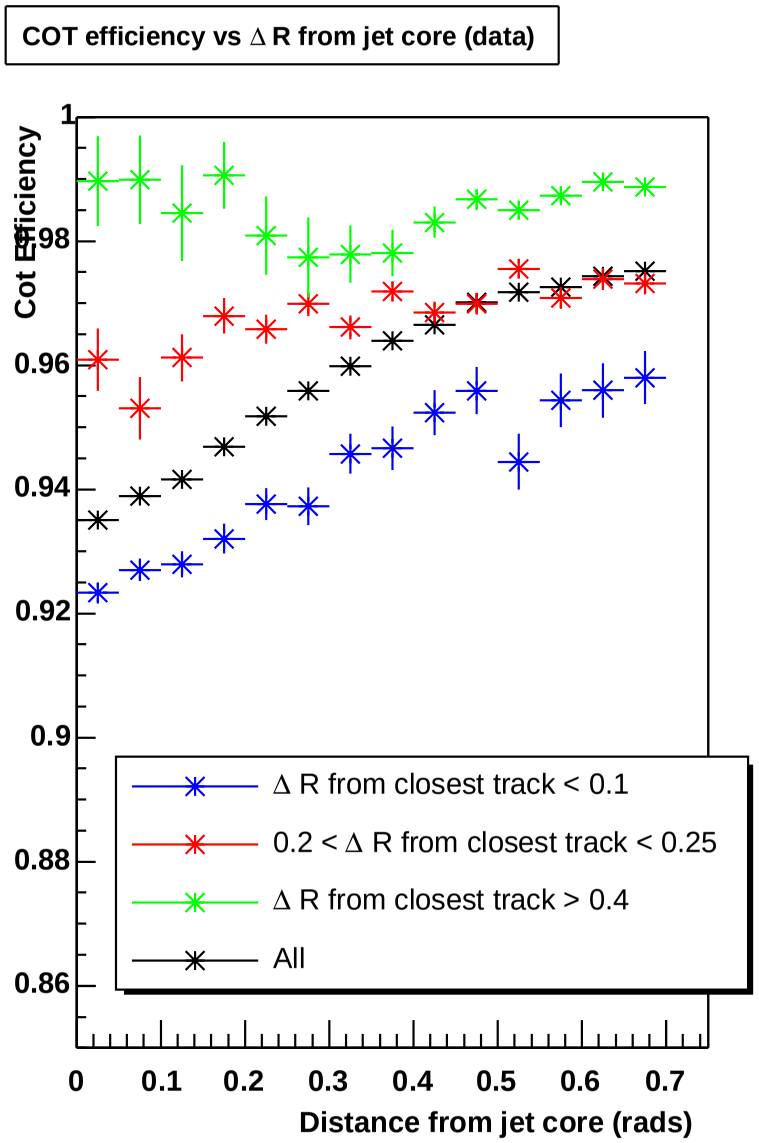

COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
Et(jet) > 60 GeV
5.0 GeV/c < Pt(track) < 10.0 GeV/c

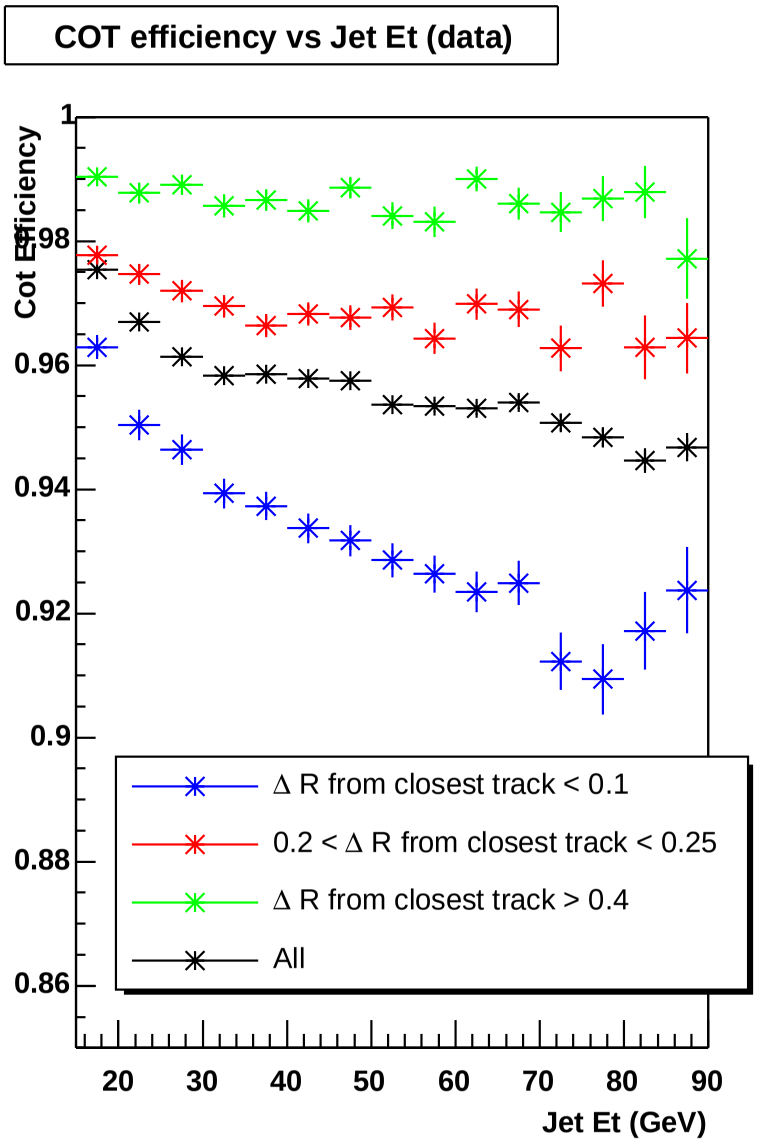

COT efficiency vs Δ R from jet core
Cot Efficiency
Distance from jet core (rads)
data
MC
Et(jet) > 60 GeV
10.0 GeV/c < Pt(track) < 15.0 GeV/c


COT efficiency vsΔ R from closest track (data)
Cot Efficiency
1
0.98
0.96
0.94
0.92
0.9
0.88
0.86
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
Closest track (rads)
Closest track has opposite charge
Closest track has same charge

- Very dependent on:
  - jet E_t
  - distance from jet core
  - track separation

  $\Rightarrow$ Investigate correlations between these effects


COT efficiency vs Δ R from jet core (data)
Cot Efficiency
1
0.98
0.96
0.94
0.92
0.9
0.88
0.86
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Distance from jet core (rads)
Δ R from closest track < 0.1
0.2 < Δ R from closest track < 0.25
Δ R from closest track > 0.4
All


COT efficiency vs Jet Et (data)
Cot Efficiency
1
0.98
0.96
0.94
0.92
0.9
0.88
0.86
20
30
40
50
60
70
80
90
Jet Et (GeV)
Δ R from closest track < 0.1
0.2 < Δ R from closest track < 0.25
Δ R from closest track > 0.4
All

Conclusion

- Track reconstruction efficiency lower in jets (around 95% average)
- Very dependent on: jet E_t, distance from jet core and $\Rightarrow$ track separation
- Jet E_t and distance from jet core effect correlated with track separation effect
- Monte Carlo result much higher (around 98.5% average)

To do:

- Correct number of hits with hit efficiency rather than hit merging distance
- Correct hit width with Penn model